Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of Part 15 Regarding New	)	**ET Docket 04-37**
Requirements and Measurement Guidelines	)	
For Access Broadband Over Power Line	)	
Systems	)	**NPRM 04-29**
	)	

Via the ECFS

ABSTRACT:

It seems fair to say that the beginning of the BPL proceedings ignited a firestorm of protest. Over one thousand comments were filed on NPRM 04-29, the introduction of Access BPL. Organizations that should be expected to favor it (such as the IEEE who would see more work for engineers, and the National Rural Electric Cooperatives, who would deploy the systems) urge more study. Organizations from the tiny "Ship Comm" (owner of four marine radiotelephone stations) to the communications behemoths Qwest, Verizon and Sprint have urged caution or opposed the deployment of BPL as currently proposed. I could find no one who submitted detailed technical analysis in their proposal who is in favor of BPL.

The thing that concerns the IEEE, ARINC, Boeing, marine service operators, the Association of Public-Safety Communications Officials-International, Inc. (APCO), Red Cross communicators, National Public Safety Telecommunications Council (NPSTC), radio amateurs, NASWB, the Society of Broadcast Engineers (SBE), DSL providers, CATV providers, and all of the other organizations that have banded together to fight BPL is simply that ***as proposed, Access BPL will surely interfere with all these services and more. The mitigation of interference is going to be a costly problem in time, money and public safety. Small businesses may be driven to bankruptcy by the costs of investigating interference and waiting for it to be removed.*** Consequently, BPL must be a good neighbor from the moment it is turned on.

Of course BPL will cause interference! How could it not? Cable TV systems that use high-quality coaxial cable ("hardline") cause interference. How could an unshielded conductor be better than that?

While I believe in the power of the market to decide, putting BPL in service at this time is like putting a defective toy on the market, one that injures children playing with it, or driving a car that belches black exhaust which chokes anyone behind it. Yes, the market would eventually stop buying it, but too many innocent citizens would be injured before that happened. Any rational person would argue not to put defective-by-design technologies on the market.

The FCC has a legal responsibility to protect licensed users of the HF radio spectrum, bound by US law and international treaties the US has signed. If BPL is to be deployed, the radiated emissions from the BPL systems must be reduced by a factor of 100,000 (50 dB). The methods for testing must be changed to accurately determine emissions in an environment never before measured.

I. A Gathering Interference Storm

The Commission is doing something historic in the introduction of BPL. Not since the Communications Act of 1934 entrusted management of the radio spectrum in the United States to

the FCC has the Commission overlaid a new service onto existing licensees and told those license holders that they must bear the interference the new service creates. **The Commission's rush to implement BPL borders on dereliction of its legal responsibility to protect international broadcasters, civil aviation, public safety, marine and other licensees from interference. This is unprecedented.**

It is true that the proposed rules say that these devices must not cause "harmful interference", but every test to date has caused harmful interference and attempts to eliminate interference have failed to completely eliminate it (apparently, some tests involved no radio spectrum users, so no interference was reported). In North Carolina, for example, Progress Energy has said it can not reduce interference further while amateurs have been denied entire bands allocated exclusively to amateur service.

"It is PEC's position and interpretation of the FCC's rules with regard to 'harmful interference' that any interference that may still exist is not 'harmful' as that term is defined by the FCC's rules," Len Anthony, PEC's attorney for regulatory affairs, told James Burtle, chief of the FCC's Experimental License Branch. "This level of interference does not seriously degrade ham radio operation or transmissions or cause repeated interruptions." No facts or measurements are presented to back up this claim. To re-phrase it more succinctly, "We say there is no harmful interference, so there is none".

Yet amateurs still report interference. According to North Carolina Public Information Officer Gary Pearce, "Nothing had changed," he told ARRL. "They were still covering up the top end of the 20-meter band." Interference to 17 and 12 meters had been notched out, but beyond that, BPL interference persisted from 14.290 to nearly 17 MHz, he said, and "fringe" carriers still encroached some 100 kHz into the bottom of 15 meters.

"***The signals on the underground lines have not changed at all," Pearce continued. "They were still full-strength across virtually every ham band if you look across the whole neighborhood***."

This situation has been reported to the FCC as required during these field tests, but nothing more has been done to remove this interference. (1) It should be noted that even notching out the amateur bands does not prevent interference to shortwave broadcasters (whom the US is obligated by international and national law to protect from such jamming), nor does it protect the civil aviation frequencies, marine, or any other services in the spectrum.

Progress Energy has even had the astonishing gall to ask amateurs not to tune their radios as a way to prevent harmful interference!! To quote from their filing, "First, the interference should have to occur in the normal course of the complainant's operations, rather than be the result of the complainant seeking out the interference." Amateurs tune their receivers around as part of the normal course of their operation. Many tune outside the amateur bands as part of the larger hobby of radio monitoring.

Make no mistake: when the interference found at the levels in these trials becomes more widespread, public safety will be compromised. Mariners at sea will not have their distress calls heard. How many will die? How many police, fire or other first responders will be put in harm's way because of interference? Will commercial aviation become less safe? The NTIA Phase I report showed that the interference fields from a fully deployed BPL system would interfere with aviation to a height of 6 km, which covers virtually all of general aviation and all airport approaches/departures. The proposed BPL baseband signals will interfere with aeronautical mobile HF (see filings by ARINC and Boeing Co.) and jam the ILS Marker Beacon frequency of 75.0 MHz. Will the harmonics of the BPL system block the VHF comm. band, including the aviation disaster frequency of 121.500 MHz? Will the harmonics block VOR/ILS services in the 108.000 to 117.975 MHz spectrum? It does not take much energy to cause a

VOR/ILS receiver to give false readings when it's near threshold. Power levels around -100 dBm at the receiver's input will cause an aircraft to change course. The Disaster Emergency Response Association (DERA) voiced many of these concerns in their filing to docket 04-37. Similar concerns were raised by the Association of Public-Safety Communications Officials-International, Inc. (APCO), and the National Public Safety Telecommunications Council (NPSTC) in their filings.

The public's safety at their doctor or hospital will be compromised. The same concerns about RF Interference that radio listeners have also extend to medical instrumentation. Magnetic Resonance Imagers and Ultrasound Imagers are very sensitive to RFI. An ultrasound imaging device is nothing but a multi-channel HF receiver that deals with weak signals (echoes returned from the body). Image degradation from BPL is virtually assured if part 15 levels remain as they are.

What about conducted emissions? Will the medical devices in hospitals and doctor's offices around the country be able to reject the HF signals on their power? Will EKGs give erroneous results, causing wrong medications to be given? Will drug delivery systems be able to withstand the interference without false-triggering? Does authorizing BPL inadvertently mandate more expensive powerline filtering for hospitals and doctors, or fallback zones around medical facilities where Access BPL can not be routed?

Homeland Security will be compromised. Although the Commission apparently ignored the report, Quantum Magnetics, a company which provides explosives detectors for airport use, replied to the NOI on this matter and stated, "QM considers the widespread adoption of BPL, in particular Access BPL, with the existing Part 15 limits on interference, to be detrimental in the application of NQR technologies for the furtherance of national security."

II. Only Those Who Will Profit From It Want It

The Commission received well over 1000 replies to its NPRM in the BPL matter along with around 5000 in the NOI. Of that group, the comments that showed experimental results or detailed numerical analysis all showed that BPL is technically and economically a bad idea. In fact, of the 18 BPL-affiliated companies who filed comments in the motion, only one presented any interference measurement data at all. (2) Yet they all claim interference is not a problem. The number of filings opposing rapid deployment appears to outnumber those supporting it by over 95 to 5%. While I can't claim to have read all of the NPRM filings, of the few replies that were in favor of BPL, I have found only one that was not from a company that stands to profit from selling the systems.

There are some comments that are particularly important to re-direct your attention to.

III. Not an Economical Approach to Broadband

On the economic side, the National Rural Electric Cooperatives stated that they do not believe BPL will be an economical method of getting broadband to rural areas.

"NRTC and NRECA, with their member rural electric cooperatives remain interested in BPL as an emerging technology, and have monitored BPL technology developments since 1997. Despite our desire for rapid BPL rollout, we caution that our research leads us to conclude that BPL technology will not be a viable solution in the near term for rural America."

The same negative conclusion about its viability was derived by economist Dr. Rahul Tongia, Ph.D. at Carnegie-Mellon University in his paper, "Promises and False Promises of PowerLine Carrier (PLC) Broadband Communications – A Techno-Economic Analysis".

Data Ventures, Inc., the BPL provider in Penn Yan, New York, site of a trial reported on in the Wall Street Journal, has stated it has no interest in providing service to remote, rural areas.

The main justification for Access BPL, to provide broadband for remote, rural users, is thus not going to be fulfilled. It is too expensive for technical reasons, the same reasons that make it an interference nightmare. The powerlines radiate far too much of the BPL signal, creating a need for many expensive repeaters.

"As an example, at a "tutorial" on BPL at the March 2004 IEEE 802 Local and Metropolitan Area Network Standards Committee plenary in Orlando, Florida, the system block diagrams presented by BPL industry representatives *clearly* indicated that repeaters would be necessary approximately *every 300 meters* along the medium and high voltage transmission lines." (3)

IV. Not a Technically Viable Approach to Broadband

The most complete and rigorous technical analysis submitted in this proceeding was the NTIA report. The NTIA Phase I Report, based on solid experimentation and modeling, though, was not unique in its conclusion that harmful interference is virtually guaranteed unless important specifications and testing methods are changed. They reached many of the same conclusions that I reached with calculator and spreadsheet, as well as the conclusions of the Boeing Company, the IEEE, the ARRL and many other technically adept individuals and organizations. This is the reason the German and Japanese governments have halted research into BPL. It's why Nortel dropped their BPL experiments in Great Britain. The Austrian government halted deployment after the Red Cross suffered extreme interference during a disaster test. The same laws of physics apply in the US.

Judging by the Commission's eagerness to implement this system, the Commission doesn't appear to be interested in the fact that this will cause interference. Is there any other reason the Commission would refuse to allow licensees in other services sufficient time to study the NTIA report? The NTIA report came out four workdays before the NPRM filings were due to close. Several individuals and groups filed for an extension of the instant NPRM so that they may study the NTIA report. These requests were summarily denied. In other, unrelated dockets, the commission granted extensions of the NPRM to single requesters reviewing far less information. **Why the disparity?**

As the IEEE stated in their submission, "SETTING COMMENT DEADLINES ON THE NPRM PRIOR TO REASONABLE PUBLIC ACCESS TO THE NTIA REPORT HAS PLACED THE PUBLIC AT A DISADVANTAGE IN FORMULATING ITS COMMENTS IN THIS PROCEEDING" (emphasis theirs).

Surely the commission has technical advisors who are capable of evaluating the technical data presented by NTIA, ARRL, etc.? Maybe not. In the Wall Street Journal 3/23/04 article on the BPL trials in Penn Yan (a singularly deceptive article when it comes to describing what's really going on in Penn Yan), author Ken Brown writes: "Ed Thomas, the FCC's chief engineer, says the commission has spent a year listening to the hams' concerns about power lines and is getting frustrated. 'Why is this thing a major calamity?' he says. 'And honestly, I'd love the answer to that.' "

With all due respect to Mr. Thomas, it's a very simple calculation to predict the power at an antenna's terminals based on an E-field. When you do that calculation and find that the result is 40 dB above signals you routinely listen to, you'll understand why ARINC, the IEEE, Boeing, ship-to-shore Marine providers, ADSL providers, cable TV companies, phone companies, and, yes, amateurs are so concerned. If you can show me a calculation that shows that a part 15 radiator

less than 30 meters from my antenna is not going to put that much signal into my system, I'd be more than happy to see it.

The NTIA report clearly shows that the part 15 levels are at least 40 dB too high, and that measuring the radiated fields as described in Part 15 will underestimate the true radiated fields. These are not surprising conclusions and are in line with my recommendations in my original filing. The following figure is from the NTIA report, and shows the proposed part 15 rules vs. limits being applied in Germany, Norway and NATO countries. The BBC/NATO limits are based on the observation that a simple desktop receiver placed 1 meter from a powerline carrying a BPL signal should not have its reception degraded by the BPL leakage.

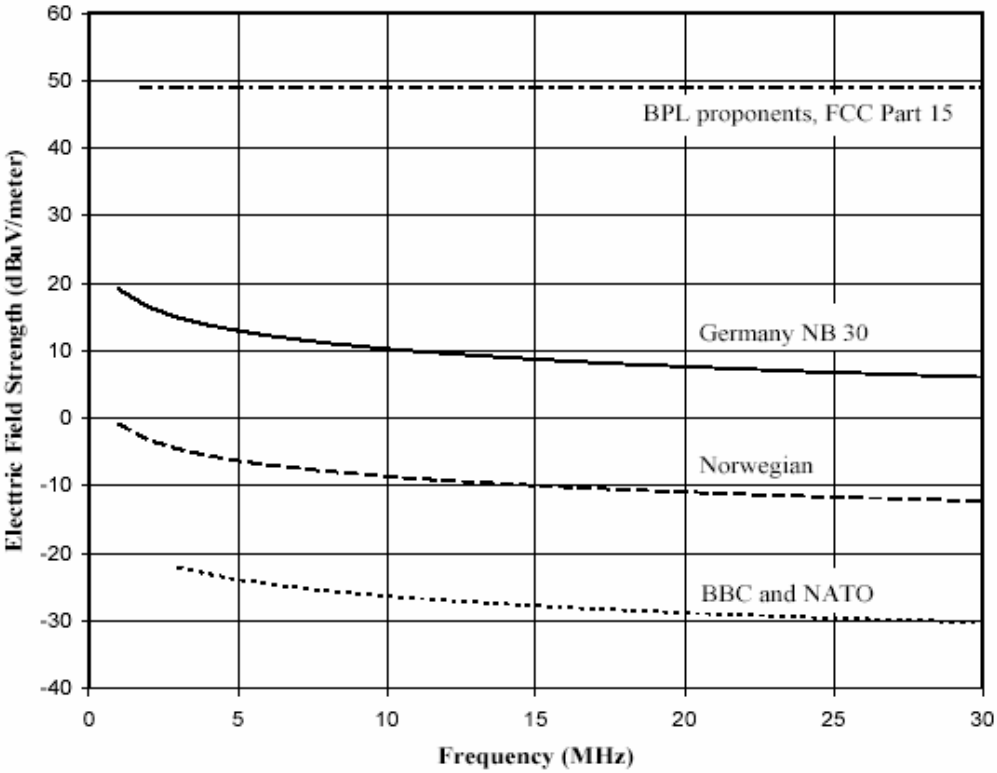

Figure 3-1: Comparison of Proposals for Regulating BPL Emissions

Given the uncertainties involved in the measurement of radiated emissions, setting the Part 15 limits at 10 dB below the NB30 specification is prudent. This is around 50 dB below the current Part 15 limits. This change to the radiated emissions specification would all but eliminate the interference to all services. For a numerical example, an inverted Vee at 7.0 MHz, an antenna with less gain than a standard dipole, the present limits for a part 15 signal from the powerline 30 meters from the antenna would put approximately -64 dBm into a receiver. My proposed limit would reduce that to nearly background noise.

The NTIA study methodically combines mathematical calculations and computer modeling to show interference to various classes of receiver (land mobile, fixed, maritime mobile and aviation mobile) at distances out to hundreds of yards. The Part 15 field (1.7-30 MHz, 30 microvolts/meter at 30 meters) is detectable in a typical commercial HF receiver out to a hundreds of meters, or ½ mile – but if BPL repeaters are spaced every 300 meters (as stated above), a user will never be that far from a source. The NTIA study shows that powerlines tend to radiate their highest fields above the line, with lobes that depend on the ratio of the line's length to the wavelength in use, and amplitudes that depend on the inherently unpredictable impedance of the powerline (every

time someone turns on or off a different appliance, the impedance of the line changes). This is a representative plot of the fields looking down the powerline (the axis intersection is the end view of the wire).

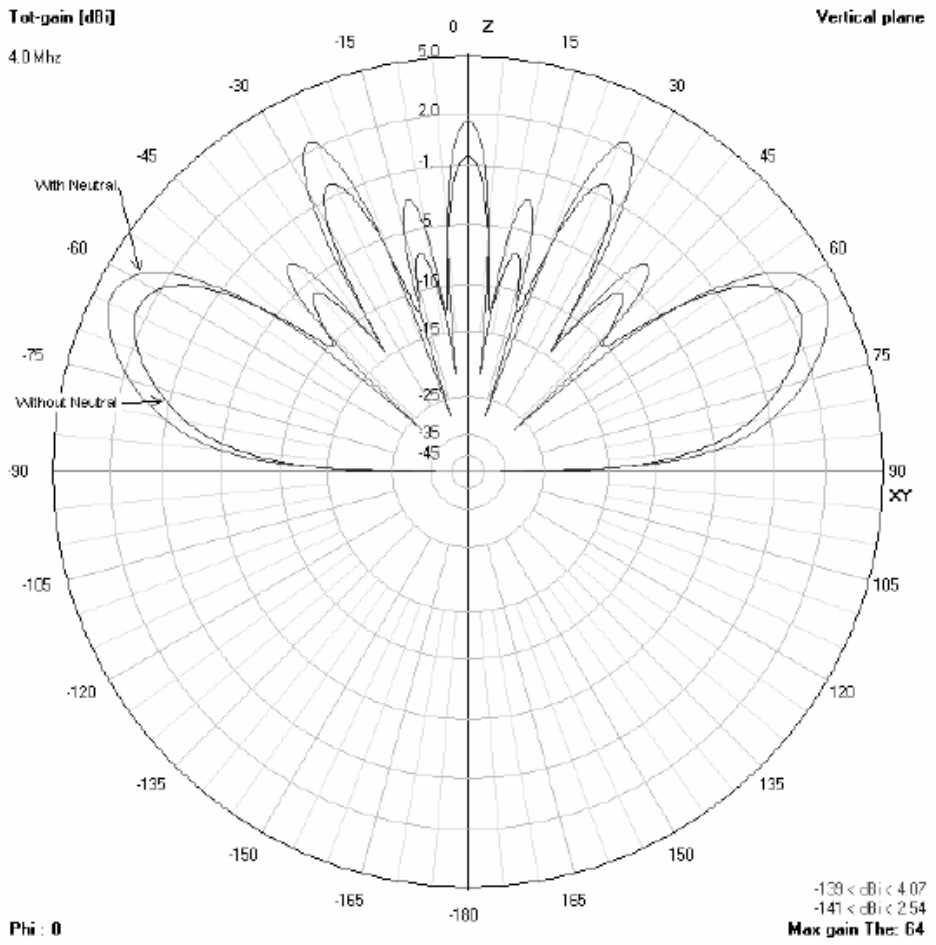

Figure 5-1: Comparison of NEC model with and without a parasitic multi-grounded neutral at 4 MHz.

As a contrast to this extensive analysis, the BPL providers state – again, without calculation or measurement to bear it out – that their lines don't radiate. For instance, in a May 20 meeting in Congress, Jay Birnbaum of BPL provider Current Communications Group, LTD. said interference was "literally undetectable" tens of meters away. (4) There is no substantiation of this statement with any data, no mention of how it was measured or any other fact to back this outrageous statement (I'm sure I'd detect it on an HF receiver, I doubt I'd detect it on an HP435B power meter; I'm sure I wouldn't detect it if I was simply looking at the wire to see if it changed color).

Powerwan states: “The BPL signals also drop off rapidly with distance, so that additive effects are minimal from adjacent systems.” Again, there is no measured data to backup the assertion that their radio emissions drop off more rapidly than any other type of radio signal. This is ruled by Maxwell, not marketing; their signals drop off at the same rate as anybody else’s. Furthermore, the NTIA study did support the contention that powerlines do radiate and the complete system needs to be qualified on site. In one case they measured, interference actually increased as distance from the powerline increased! (NTIA Report 04-413, paragraph 5.3.3).

The NTIA is chartered only with managing the Federal Government’s communications services. They present a list of 41 frequency bands that they want “notched out” of any BPL systems. The National Academy of Sciences says they want the Radio Astronomy services “notched out”. When these are added to the notches for the amateur bands, marine, broadcasting and every other existing service in the 1.7 to 80 MHz spectrum – along with the technical uncertainty surrounding “notching out” anything (i.e., how well can these notches be implemented, in terms of equivalent loaded Q) – and it quickly becomes apparent that this leaves almost no spectrum for BPL systems. It’s a classic case of “all hole and no donut”. Clearly the answer must be to lower the radiation limits on BPL systems.

V. A Hidden Problem

There’s a problem hidden in the technical plots from the NTIA. The angle at which the powerlines radiate, 25 degrees, is in the realm of the optimum angle for HF communications. This is an angle that systems engineers designing long-haul links strive for in their antenna system designs. What does this mean? It means that the BPL signals are likely to be propagated across long distances during favorable conditions.

Amateurs no longer consider contacts at 100,000 miles per watt as outrageously rare. Bragging rights go to those who work millions of miles per watt or more, with one amateur reporting over 100,000,000 miles per watt. BPL will be detectable via ionospheric skip during periods of good propagation.

The HF spectrum is a unique and wonderful gift from God. Only in this one relatively small range of frequencies, in a spectrum that extends from DC to infinitely high frequencies, can worldwide propagation occur without repeaters, satellite or other infrastructure. After being involved with radio, professionally and as a hobby, for almost forty years, it still seems magical that I can send a meager signal, equal in power to a common night light, out of a simple wire antenna and talk with someone else on the other side of the world. The US is obligated by ITU treaty to protect the 5-30 MHz band from interference and protect it for international use. **It is the legal responsibility of the FCC to *prevent* interference to licensed users of HF, not mitigate it.**

VI. Problems Not Addressed in the NPRM

There are technical problems not mentioned in the NPRM or other discussions of BPL that must be addressed before implementing such systems on a broad scale. Issues of responsibility for compliance when a variety of items are connected to BPL signals need to be addressed in more detail.

Individuals must be able to block BPL from their homes if they don’t desire the service. In several of the PR statements made by companies planning BPL systems, the impression is given that the modem will the enabler, and the BPL signal will be in everyone’s home whether they subscribe or not. It is outrageous to be subjected to a strong, undesired RFI signal in one’s own home!

While I realize this is not EMI-related, the transition from the MV power line to the LV power side is not discussed. The BPL bridges that connect the MV lines (typically several kV) to the 120 V consumer lines need to be failsafe devices. They can not be allowed greater than a 10^{-10} chance

of failing “shorted” and putting thousands of volts on household wiring. When broadly deployed (10 million devices), such a number will yield a roughly 1 in 1000 chance that some home in the US will be blown up every year. As one who lives in the lightning capital of the US, the robustness of such devices in the presence of lightning strikes is a first thought.

VII. What Must Be Done

The CFR 47 Part 15 is the key to what must be done.

§ 15.15 General technical requirements.

§ **15.15(C)** "*Parties responsible for equipment compliance should note that the limits specified in this part will not prevent harmful interference under all circumstances*. … *operators of part 15 devices are required to cease operation should harmful interference occur to authorized users of the radiofrequency spectrum*. “

§15.113(b) "*The operating parameters of a power line carrier system (particularly the frequency) shall be selected to achieve the highest practical degree of compatibility with authorized or licensed users of the radio spectrum*."

§15.113(c) "*Power line carrier system apparatus shall be operated with the minimum power possible to accomplish the desired purpose.*"

47 CFR Part 15 has always stated that these devices are incidental radiators. They have no *right* to any portion of the radio spectrum. They must be operated in such a way as to cause no interference, and they must accept interference with no recourse. They must choose frequencies to not interfere with other services and they must use the minimum power necessary to communicate. If they interfere, they must be shut down.

The FCC must maintain this distinction that the HF license holders’ rights outweigh the rights of BPL systems. BPL systems must notch out, or be deployed physically around, aeronautical ground stations, fixed marine, SWBC, EAS, military, radio astronomy, NIST, MARS, and amateur service frequencies. The NTIA Phase I Report showed interference out to almost ½ mile – this is the distance BPL must be kept from these services. The BPL frequencies must be changeable on an immediate basis – meaning “NOW!” not “tomorrow” or “next week” (as stated in the IEEE comments, p. 4, footnote 1).

The NTIA’s recent filing in this matter recommended an *a priori* survey of radio users in a community, so that the BPL providers can notch out desired frequencies before starting deployment. I strongly support this, but it is not strong enough. While use of the Commission’s license database would allow providers to contact marine, aviation, amateurs and other license holders, it will not provide addresses of casual radio listeners, shortwave listeners or CB’ers. This can only be accomplished by survey of every mailing address in a target area. Even so, providers will likely develop problems as new interest in radio develops in an area.

The Part 15 Radiated Emissions levels being imposed are at least 100,000 times (50 dB) too high.

(1) I urge the FCC to adopt a requirement 10 dB more stringent than the German NB30 limit.

(2) I am not conversant in the conducted emissions problems with BPL; however the effect on medical and other life-critical gear needs to be studied.

(3) While this emission limit is challenging, it is more realistic than ensuring that the wires carrying BPL signals are physically never closer than ½ mile to any of the above named services, especially since some of those services can change their location at any time.

The measurement methods outlined in Part 15 will present overly optimistic results.

(4) BPL measurements must follow the recommendations of the NTIA. Important points are:

a. The measuring antenna must be at 10 meters or higher – above the powerline gives a more accurate measurement than below it.

b. Multiple measurements around the BPL repeater and the attached powerlines must be made. Don't simply measure at some point and extrapolate. In some cases, the signal actually increased as the measurement antenna was moved further from the powerline.

c. Do not use the slant range method mentioned in Appendix C of the NPRM for setting distance to the powerline. Any measurements made will be made in the near field, subject to ground reflection effects and the change in direction of the EM fields between the powerline and ground. It is a principal of electromagnetism that electric fields will intersect grounds at a right angle, so that between the powerline and ground the E-field will go from predominantly horizontal to predominantly vertical. This change takes place for some distance radially from the powerline and will cause a measuring antenna to get unpredictable readings.

D. Use an electric field measuring antenna at all frequencies, not just above 30 MHz. In the far field, the ratio between electric and magnetic fields is fixed. In the near field (any measurements below 30 MHz will be near field), however, the ratio varies dramatically and no convenient calibration factor exists. Since the vast majority of users in the HF spectrum use an E-field antenna, measurement with a magnetic field antenna may drastically underestimate the amount of interference that will occur.

VIII. In Conclusion

In many ways, the HF spectrum is the worst possible place to put a service like BPL. It is capable of worldwide propagation of weak signals. It is home to AM and suppressed carrier modes that are particularly sensitive to interference. And it is home to disaster communications, marine, civil aviation, ESA, FEMA, Military, medical, homeland defense and other systems that take place with low signal levels. Since every field test and every piece of analysis has shown harmful interference from BPL, it is guaranteed to cause interference and needless costs. You could not find a worse place to put a service like BPL.

The Commission's more recent NPRM, docket 04-113 which seeks to place wireless broadband services in unoccupied TV channels is a much more logical way to deploy broadband. This is unused – wasted – spectrum; the HF spectrum is full of users.

The best thing to do with BPL is take it off the powerlines and officially make it a wireless service, because it already is a wireless service. Allocate spectrum to it and be done with it.

It BPL is to stay on the powerlines, the Corridor technologies approach needs study. They use much higher frequencies, provide higher data rates, and less interference. If BPL is to be assigned in the 1 to 80 MHz range, the only way to save the existing services, and to meet the legal requirements on the FCC and the international treaties governing HF, is to lower the radiated emissions limits by 50 dB.

Never before has the Commission instituted a new service on the legally allocated spectrum of other users and told them to accept whatever interference they get. Now is not a good time to start.

Respectfully submitted,

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Although I am a design engineer for Rockwell Collins, Inc., I am not representing them in this reply. My concerns are for civil aviation, public safety, SWBC, and amateur radio.

(1) ARRL, http://www.arrl.org/news/stories/2004/04/22/2/

(2) Comments filed by petitioner Leonard Anderson, Life Member of the IEEE, 11 May 2004.

(3) Comments filed by petitioner Carl R. Stevenson, Communications Systems Engineer and amateur WK3C.

(4) ARRL, http://www.arrl.org/news/stories/2004/05/20/1/